MEMORANDUM

NOVEMBER 27, 2018

TO: File

FROM: Mike Surasky, PE, PTOE and John Page, CEP, AICP

SUBJECT: Potential Traffic Capacity Constraints on Development to Support Updated Indirect and Cumulative Effects (ICE) Analysis for the R-2576 Mid-Currituck Bridge Final Environmental Impact Statement)

DATE: November 27, 2018

INTRODUCTION

This analysis has been developed to examine the potential for roadway capacity to constrain development along the NC 12 portion of the Outer Banks north of US 158 in Dare and Currituck counties. This memorandum has been prepared as an update to the February 20, 2012 Technical Memorandum which was developed in response to Draft Environmental Impact Statement (EIS) comments related to assumed development in the area. The 2012 Indirect and Cumulative Effects (2012 ICE) analysis had the following primary observations:

- With the No-Build Alternative, it is reasonable to assume that development would be constrained to approximately 83 percent of the forecast 2035 levels of development (planned and expected development) for area.
- With ER2, NC 12 would be widened to three lanes, so development would be constrained to approximately 88 percent of the forecast 2035 levels of development (planned and expected development) for the area (an increase of 5 percent over the No-Build Alternative).
- Applying constrained development levels to the maximum build-out of 15,418 units from Southern Shores to the Virginia line shows a potential constraint on development at 70 percent of build-out with the No-Build Alternative and 75 percent with ER2.
- With the Preferred Alternative, roadway capacity does not constrain development in the area from reaching the current planned and expected development levels.

This analysis is being updated to reflect the latest traffic forecast dated June 15, 2016. The updated forecast provides 2040 traffic volumes for the project area (as opposed to 2035 in the previous forecast). A new forecast was required for multiple reasons including:

- Lower growth rates than anticipated in the 2035 forecast have been observed in the project area between the 2006 base year and 2015.
- The previous 2035 forecast was less than 20 years past the 2019 let year.
- The previous 2035 forecast was more than 5 years old.

This memorandum re-examines the assumptions of the constrained traffic analysis prepared in 2012[1] using the 2035 forecast and provides an updated analysis based on similar methods to those applied in the 2012 analysis. It addresses revised versions of the No-Build Alternative, ER2, and the Final EIS Preferred Alternative (Mid-Currituck Bridge) that are associated with the 2016 traffic counts and 2040 traffic forecast. Therefore, results associated with the 2040 forecast and updated traffic analyses are for the revised alternatives. The results of this memorandum are used in the Final EIS reevaluation report.

ASSUMPTIONS

Multiple assumptions were applied in this analysis regarding land use and congestion constraints.

LAND USE ASSUMPTIONS

The land use assumptions are described for the following three topics:

- Land Use Zones
- Existing Levels of Development
- Maximum Build-out and 2040 Planned and Expected Levels

LAND USE ZONES AND TRAFFIC LINKS

Within Table 1, the land use development is broken into 9 zones (J through P) as utilized in the 2040 forecast. This provides a more detailed analysis than the 2012 analysis which examined four zones (A through D) for the same geographic area. An illustration of the zone locations is shown in Figure 1 . An illustration of the traffic links created for the traffic analyses is shown in Figure 2.

Table 1. Existing (2014) Development along NC 12

Zone in 2040 Forecast	Equivalent Zone in the 2012 Analysis	2007 Units utilized in Previous Forecast	New Units / Building Permits 2007-2014	2014 Existing Units	Annual Growth Rate 2007-2014
P	A	611	120	731	2.59%
O1, O2	B North	1,553	24	1,577	0.22%
N1, N2	B South	2,123	214	2,337 (with 291 hotel rooms)	1.38%
L, M	C	1,839	44	1,883	0.34%
J, K	D	2,910	127	3,037	0.61%
Total		***9,036***	***529***	***9,565***	***0.82%***

[1] Documented in a February 20, 2012 memorandum titled "Analysis of Potential Traffic Capacity Constraints on Land Use Growth to Support Updated Indirect and Cumulative Effects (ICE) Analysis for Mid-Currituck Bridge Final Environmental Impact Statement (FEIS)."

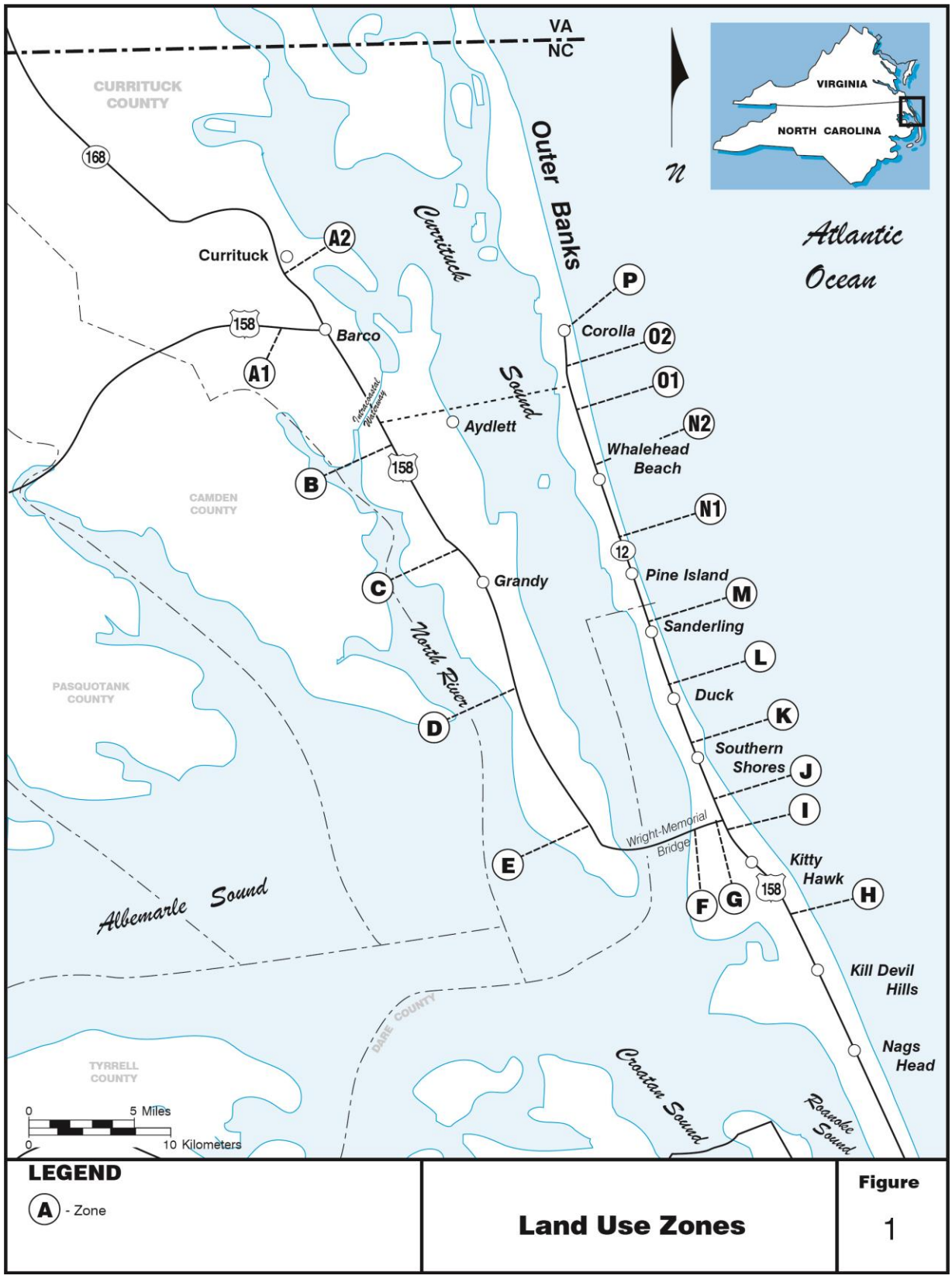

Figure 1: Land Use Zones

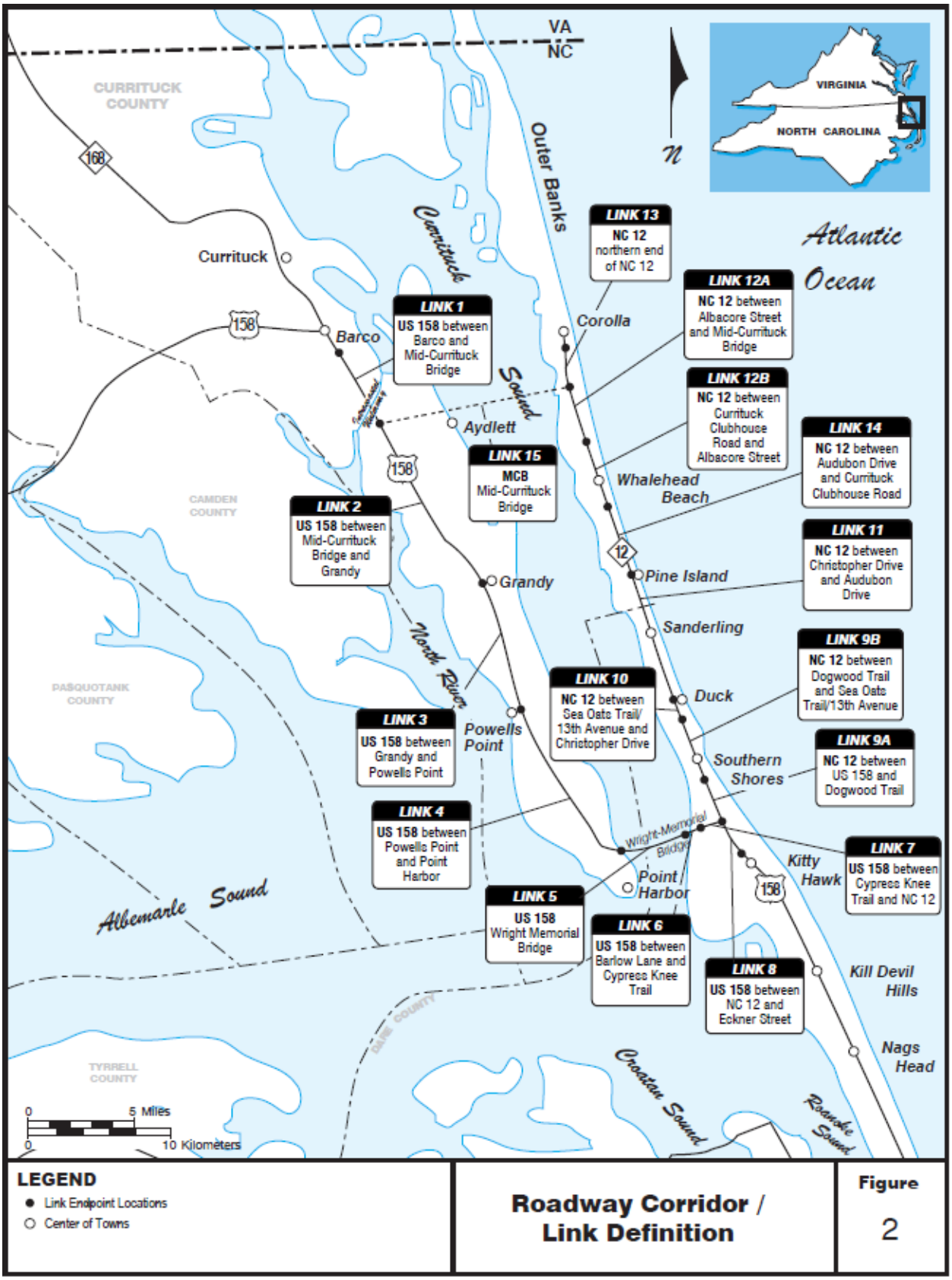

Figure 2. Link Definitions

EXISTING LEVELS OF DEVELOPMENT

Over the course of the Mid-Currituck Bridge study, existing levels of development in the project area have steadily increased. For this update of the 2012 analysis, building permits issued in the project area were examined to identify growth between 2006 and 2014. The data included information for both the NC 12 sections of the Outer Banks and the non-road accessible portion north of Corolla. This data is presented in Table 1.

A comparison of growth rates for the project area reflect the slowdown in the area. Specifically, the overall annual increase in housing units was 0.82 percent per year from 2007 to 2014 compared with a rate of 1.41 percent per year from 2001 to 2007. The fastest growing zone in the project area is Zone P located north of the NC 12 accessible sections of the project area.

MAXIMUM BUILD-OUT AND 2040 PLANNED AND EXPECTED LEVELS

Within the project area, the Outer Banks area served by NC 12 is essentially a 20-mile section of two-lane roadway with multiple cul-de-sacs and short roadways providing access to local development. Given the physical constraints of the Atlantic Ocean and the Currituck Sound, as well as that most of the area is already subdivided or has in place plans that specify certain maximum development levels, there is a physical limit to the amount of development that can occur on the Outer Banks.

Recognizing these development limitations, the build-out potential for dwelling units (combination of houses and hotel rooms) was examined in the 2012 analysis and is reexamined as part of this analysis. In order to update the 2012 analysis, data from the updated 2040 forecast and development trends since 2007 (the base year for the 2012 analysis) were examined. This review showed a general slowdown in development within the project area, but did not provide any indication that the maximum buildout potential had changed. The number of platted lots and proposed hotel rooms allowing for future development remained constant over this period. Therefore, the maximum build-out potential was assumed to remain the same as in the previous 2012 analysis. The maximum build-out potential for the project area is illustrated in Table 2.

Planned and expected development by 2040 is defined as the number of dwelling units assumed to be developed along NC 12 and the non-road accessible area in the official traffic forecast for the 2010 Draft EIS and for the updated traffic forecast dated June 2016. This assumes NC 12-accessible areas is built out (all planned units develop) and lots in the non-NC 12 accessible area continue to develop to 2040 based on past growth trends.

The 13th Avenue/ Sea Oats Trail intersection with NC 12 is the critical congestion intersection which splits the project area in Southern Shores with zones J and K located south of the congestion point and all other zones (L through P) located to the north. As in the previous 2012 analysis, the buildout analysis assumes that all zones south of the critical intersection will be developed to maximum buildout. North of the critical intersection, development potential and possible congestion restraints will be examined to identify potential ICE issues. Table 2 illustrates the potential growth limits for these zones north of the critical congestion intersection.

Table 2. Growth Limits and Growth Rates

Zone in 2040 Forecast	Equivalent Zone in the Previous ICI Analysis	2014 Existing Units (from Table 1)	Maximum Build-Out	Planned and Expected Develop-ment	2014 to 2040 Additional Units	Projected Growth Units	Annual Growth 2014-2040 (assuming buildout reached in 2040)
P	A	731	3,150	854	123	17%	0.60%
O1, O2	B North	1,577	1,750	1,750	173	11%	0.40%
N1, N2	B South	2,337 (includes 291 hotel rms)	5,119 (includes 1,373 hotel rms)	5,119 (includes 1,373 hotel rms)	2,782	119%	3.06%
L, M	C	1,883	1,999	1,999	116	6%	0.23%
J, K	D	3,037	3,400	3,400	363	12%	0.44%
Total Planned and Expected		*9,565*	--	*13,122*	*3,557*	*37%*	*1.22%*
Total Maximum Build-out		*9,565*	*15,418*	--	*5,853*	*61%*	*1.85%*
Total excluding Zones J & K	*Total excluding Zone D*	*6,528*	*12,018*	*9,722*	*3,194*	*49%*	*1.54%*
Total NC 12 Accessible excluding Zones J, K & P	*Total NC 12 Accessible excluding Zones A & D*	*5,797*	*8,868*	*8,868*	*3,071*	*53%*	*1.65%*

Notes:

- The above table summarizes growth limits based on review of subdivided lots and a review of developable lots, as well as hotel rooms. The growth limits are unchanged from the 2012 analysis.
- Zones L, M, N1, N2, O1, O2 and P are north of the critical intersection, i.e. NC 12 at 13th Avenue/Sea Oats Trail.
- Zones J and K are south of the critical intersection, i.e. NC 12 at 13th Avenue/Sea Oats Trail. These zones are assumed to reach full buildout without congestion constraints.
- For Zone P, it is assumed that the development limit by 2040 would be 854 of the 3,150 subdivided lots in the beach access area north of NC 12. See Section 4.3 of the June 2016 report *Project Level Traffic Forecast Report* under "Non-Road Accessible Section north of Corolla and NC 12" for a description of the basis of the 854 units by 2040.
- Annual growth rate is computed assuming planned and expected development will occur in 2040. Depending upon future development rates, it is possible that buildout in the NC 12-accessible areas will be reached before 2040

North of the road-accessible section, there are a total of 3,150 total lots (Zone P in this traffic analysis). Consistent with previous analysis, it is assumed that this level of build-out is not practical north of NC 12. Restrictions on development include the area's lack of federal flood insurance, lack of local paved roads and public services, and designation as a limited service area and land with low suitability for development in the Currituck County CAMA land use plan. In addition, there are commitments in place not to extend NC 12 further north.

CONGESTION RELATED ASSUMPTIONS

In addition to the land use assumptions, this updated analysis required a review of congestion characteristics and determination of maximum traffic capacity (both hourly and daily).

CRITICAL CONGESTION INTERSECTION

The original constrained capacity analysis conducted in 1995 was based upon an assumption that there was a maximum daily volume that could be served on a two-lane section of NC 12 just south of the three-lane section in Duck. Further north of this point, land use growth eventually would be constrained recognizing that additional trips up NC 12 would not be able to occur on the summer weekend. This point in the roadway network was previously referred to as the critical link and is now defined as the critical point.

For this updated analysis, a detailed review was conducted of traffic patterns and operations on NC 12 in Dare County. Based on this review, the specific location of the critical congestion point was identified as the intersection of NC 12 with 13th Avenue/Sea Oats Drive. This intersection is further south (0.7 miles) than the previous analysis which had the critical link in southern Duck.

The selection of the 13th Avenue/Sea Oats Drive intersection with NC 12 as the critical point in this 2017 analysis is based on multiple factors including:

- Traffic flow for through traffic is most constricted at traffic signals, since the red and yellow times for northbound flows result in stops that delay through vehicles and create congestion.
- Synchro analysis shows this as the most congested intersection along NC 12 with the highest Intersection Capacity Utilization percentage.
- This intersection is also a 4-leg intersection with multiple turn movements conflicting with through traffic.
- The western leg to this intersection (Sea Oats Drive) provides an alternative route for vehicles wishing to access US 158. This route is very circuitous, low speed, and requires multiple turns, but a small volume of diversions would result in both more green time for the side road as well as a slight reduction in through vehicles on NC 12 south of this intersection.

For this re-analysis of constrained development, the anticipated maximum peak hour flow and maximum daily flow have been updated based on new traffic counts collected in the summer of 2015 at the critical link and intersection. In addition, HCM 2016 (6th) Edition has been used to determine hourly capacity on NC 12 (previously the HCM 2000 capacity was used).

MAXIMUM HOURLY TRAFFIC

The two-way hourly capacity on NC 12 was determined using HCS 7 software (version 7.2.1) Two-Lane Highway tool. HCS 7 software is based on HCM 6th Edition methodology. Table 3 shows the assumptions used to calculate hourly capacity for NC 12.

Using the assumptions in Table 3, hourly capacity for NC 12 two-lane highway segment is 2,550 vehicles per hour (vph). Recognizing the effect of the traffic signals, a ratio of 75 percent for green time in each traffic signal cycle (the g/C ratio) was assumed to determine capacity for the two-lane arterial segment. This ratio reduces the uninterrupted capacity to reflect that the major through movements on NC 12 are restricted by a red traffic signal 25 percent of the time. Based on this, the hourly capacity on NC 12 was

Table 3. NC 12 Capacity Assumptions

HCM 6th Edition Input	Two-Lane (NC 12)
Cross-section	Two-Lane
Class	Class III
Segment Length (mi)	4.0
Lanes in each direction	1
Lane Width (feet)	12
Shoulder Width (feet)	2
Terrain	Level
Access-Point Density	16
Free-Flow Speed Method	Estimated
Base Free Flow Speed (mph)	52
Trucks and Buses	2%
Recreational Vehicles	5%
Directional Split	60-40
Peak Hour Factor	0.90
Percent No-Passing Zones	100%
Passenger-Car Equivalents for Trucks	1.0
Passenger-Car Equivalents for RVs	1.0

calculated as approximately 1,913 vph. Table 4 shows hourly capacity threshold for four different roadway types based on Two-Lane Highway methodology. For three-lane sections with two-way-left-turn-lanes (TWLTL), it was assumed that hourly capacity is 13 percent higher than two-lane sections.

The critical point on NC 12, just north of 13th Avenue/Sea Oats Drive intersection, has hourly capacity of 1,913 vph for the revised No-Build Alternative and 2,162 vph for the revised ER2 Alternative.

Table 4. NC 12 Hourly Capacity (Max Volume)

NC 12 Cross-Section	Capacity	Methodology
Two-Lane Highway	2,550	Based on HCM 6E Chapter 15: Two-Lane Highways; with assumptions in Table 3
Two-Lane Arterial	1,913	25% lower than Two-Lane Highway based on g/C = 0.75
Three-Lane (TWLTL) Highway	2,882	13% higher than Two-Lane Highway
Three-Lane (TWLTL) Arterial	2,162	13% higher than Two-Lane Arterial

MAXIMUM DAILY TRAFFIC

The daily capacity for critical point on NC 12 was determined by applying a diurnal distribution with prolonged peak hour spreading (LOS F capacity for 10 hours) and a peak-hour factor (k) of 6.0 percent. Similar methodology and assumptions were used in the original 1995 analysis and the 2012 analysis (i.e., LOS F for 10 hours with prolonged peak hour spreading).

A comparison of the maximum daily capacity from 2012 and the current analysis is provided in Table 5. For the 2012 analysis, the assumed maximum daily volume was 35,000 vehicles per day (vpd). This maximum daily volume was computed using a peak hour capacity of 2,218 vph along with a 10-hour peak period and lower traffic volumes in additional 4 hours in the morning and 4 hours in the afternoon (beyond the 10 hours of full capacity).

Table 5. Maximum Daily Capacity (Max Volume) on NC 12 at Critical Point

Hour Starting	2012 Analysis Maximum Capacity		2017 Analysis Maximum Capacity	
	Hourly Volume (vph)	Percentage (of Daily)	Hourly Volume (vph)	Percentage (of Daily)
12 AM	310	0.9	300	0.9
1 AM	182	0.5	250	0.8
2 AM	114	0.3	250	0.8
3 AM	78	0.2	250	0.8
4 AM	102	0.3	300	0.9
5 AM	512	1.5	600	1.9
6 AM	932	2.7	1,300	4.1
7 AM	1,500	4.3	1,700	5.3
8 AM	2,013	5.8	1,900	6.0
9 AM	2,218	6.3	1,913	6.0
10 AM	2,218	6.3	1,913	6.0
11 AM	2,218	6.3	1,913	6.0
12 PM	2,218	6.3	1,913	6.0
1 PM	2,218	6.3	1,913	6.0
2 PM	2,218	6.3	1,913	6.0
3 PM	2,218	6.3	1,913	6.0
4 PM	2,218	6.3	1,913	6.0
5 PM	2,218	6.3	1,913	6.0
6 PM	2,218	6.3	1,913	6.0
7 PM	2,183	6.2	1,900	6.0
8 PM	2,026	5.8	1,700	5.3
9 PM	1,524	4.4	1,300	4.1
10 PM	887	2.5	600	1.9
11 PM	457	1.3	400	1.3
Daily Total	35,000	100	31,880	100

Note: Red highlighting indicates 10-hour period with LOS F maximum flow. Orange indicates additional hours with assumed peak hour spreading. A congested LOS E occurs in all but the first and last hours of peak hour spreading.

For this updated analysis, the assumed maximum daily volume for No-Build is 31,900 (31,880 rounded up to 31,900). This maximum daily volume is computed using a peak hour capacity of 1,913 vph along with a 10-hour peak period and lower traffic volumes in additional 4 hours in the morning and 4 hours in the afternoon (beyond the 10 hours of full capacity).

For the revised ER2 alternative, the maximum daily volume is assumed to be 13 percent higher than the revised No-Build alternative. Accordingly, the maximum daily volume for the revised ER2 with a three-lane arterial section on NC 12 between US 158 and north of Duck, including the critical link north of 13th Avenue and Sea Oats Trail intersection, is assumed to be 36,000 vpd. Table 6 summarizes the hourly and daily capacity assumed for the revised No-Build and ER2 alternatives.

Table 6. Assumed NC 12 Hourly and Daily Capacity (Max Volume)

Alternative	NC 12 Cross-Section	Max Hourly Volume	Max Daily Volume
Revised No-Build	Two-Lane Arterial	1,913	31,900
Revised ER2	Three-Lane (TWLTL) Arterial	2,162	36,000

OTHER ASSUMPTIONS

Applying the land use and congestion related assumptions in the previous sections, two key factors required examination before computing potential congestion related constraints on development. These two analysis steps include:

- Comparison of Traffic Forecasts with Maximum Daily Capacity
- Estimation of Theoretical Trip Rates for Traffic at NC 12 South of Duck

COMPARISON OF TRAFFIC FORECASTS WITH MAXIMUM DAILY CAPACITY

To compare the current analysis to the 2012 analysis, a comparison of traffic forecasts at three network links was conducted for the 2035 and 2040 forecasts, presented in Table 7. This step was required to determine the roadway links with congestion that would potentially constrain development. The three network links examined for potential congestion constraints are:

- The section of NC 12 immediately north of the critical point of NC 12 at Sea Oats Trail/ 13th Avenue intersection (in previous constrained development analyses referred to the section just south of Duck).
- The section of NC 12 just south of the proposed Mid-Currituck Bridge
- The proposed Mid-Currituck Bridge

Table 7. Traffic Forecast Comparison to Maximum Capacity (Max Volume) – Summer Weekend

Link	2035 Forecast (superceded)			2015 Volumes (vpd)	2040 Forecast		
	2006 Volumes (vpd)	2035 No-Build (vpd)	2035 Build (vpd)		Revised 2040 No-Build (vpd)	Revised 2040 ER2 (vpd)	Revised 2040 Build Bridge (vpd)
NC 12 North of 13th Avenue	28,800	44,100 (26% greater than max daily capacity of 35,000 vpd)	30,600	27,000	42,800 (34% greater than max daily capacity of 31,900 vpd)	42,800 (19% greater than max daily capacity of 36,000 vpd)	25,000
NC 12 South of Proposed MCB	20,900	31,400	34,600 (at/near max daily capacity of 35,000 vpd)	13,000	14,200	14,200	21,400
Proposed Mid-Currituck Bridge	NA	NA	22,500	NA	NA	NA	18,000

Note: Volumes were taken from 2035 and 2040 Traffic Forecast Reports completed in 2009 and 2016 respectively.

A review of Table 7 traffic forecasts and comparison with the estimated maximum traffic flows indicates that:

- The updated 2040 forecast is lower than the 2035 forecast at each of the three links examined for potential development constraints caused by congestion. Based on this alone, the potential development constraint should be less with the 2040 forecast than the 2035 forecast.
- For the No-Build Alternative just north of the 13th Avenue signal, the 2040 summer weekend traffic forecast of 42,800 vpd exceeds the maximum daily capacity of 31,900 vpd by 10,900 vpd (34 percent) on NC 12 north of 13th Avenue (i.e. the critical point). Therefore, the No-Build Alternative could constrain development from reaching planned and expected levels.
- The 2040 ER2 forecast volumes are the same as the 2040 No-Build Alternative forecast with 42,800 vpd anticipated without congestion constraints. Recognizing that a three-lane section has a capacity approximately 13 percent higher than a two-lane section, it is assumed that the maximum daily capacity for a three-lane road is 36,000 vpd. Even with the increased capacity from three lanes, roadway capacity on NC 12 could constrain development (approximately 19 percent above maximum capacity) under the 2040 ER2 scenario.
- The traffic forecasts for the NC 12 link just south of the proposed Mid-Currituck Bridge are 14,200 vpd and 21,400 vpd for the no bridge (revised No-Build and ER2 alternatives) and build bridge (revised Preferred Alternative) scenarios respectively, which is substantially lower than the 35,000 vpd maximum daily capacity. Therefore, this roadway section is not the source of potential development constraints for the 2040 revised No-Build , ER2, or Preferred Alternatives. Note that in the 2012 analysis, this part of NC 12, just south of the proposed Mid-Currituck Bridge, was forecasted to attract 34,600 vpd, which was very near the maximum roadway capacity of 35,000 vpd.
- The 2040 forecast for the proposed Mid-Currituck Bridge (revised Preferred Alternative) is 18,000 vpd which is lower than the 2035 Mid-Currituck Bridge forecast of 22,500 vpd at the same link. In either case, the two-lane section on the Mid Currituck Bridge will not cause congestion issues on NC 12 that could constrain development.
- This analysis has not considered the implication of roadway capacity constraints limiting development on the non-road accessible portion of the beach. In any case, it should be acknowledged that the maximum daily capacity on the beach itself would be much lower than the 31,900 vpd identified for NC 12. In addition to lack of infrastructure, tidal patterns could also restrict travel on the beach section.

ESTIMATION OF THEORETICAL TRIP RATES FOR TRAFFIC ON NC 12 SOUTH OF DUCK

As part of the original 1995 constrained development forecast, an important assumption with the No-Build Alternative was that a trip rate could be applied at the critical link south of Duck (or at other locations as needed) to iteratively determine the amount of development that could occur north of that location based on an assumed maximum daily roadway capacity (i.e., 23,400 vpd on a two-lane NC 12). This trip rate was determined by dividing the number of trips occurring at a given roadway link by the amount of development located north of the link. For this methodology, the amount of development was assumed to correspond with the number of total dwelling units (houses and hotel rooms). In the

case of the NC 12 link south of Duck, this requires dividing the estimated trip volume by the total number of developed lots in Zones A, B, and C, as presented in Table 8.

With the 2035 forecast and the updated 2040 forecast, this trip rate methodology was revised to examine origin-destination patterns and growth at specific zones more closely. Nevertheless, this analysis has documented this theoretical trip rate when comparing the effect of potential development constraints caused by congestion. In addition, when computing the level of potential development constraints, it is assumed that the trip rate remains constant with and without land use constraints.

Table 8 provides a computation of this theoretical trip rate under multiple scenarios. As shown, the differences in the 2012 analysis and this 2017 analysis are minimal. The 2040 forecast shows a slightly lower volume (42,800 versus 44,100 vpd) and a lower trip rate (4.4 trips per unit versus 4.5 trips per unit) that the superceded 2035 forecast with the same levels of planned and expected development assumed. Note that the planned and expected development north of the critical point dropped slightly as part of this analysis because of a slight shift in the location of critical flow used in the analysis.

Table 8. Comparison of Trip Rates at NC 12 South of Duck

Scenario	NC 12 Summer Weekend Daily Traffic Volume (vpd)	Developed Dwelling Units North of the Critical Point (Zones L, M, N, O, P)	Trip Rate South of Duck (trips/du)	Observations
Existing (2014 land use, 2015 volume)	27,000	6,528	4.1	Based on 2015 Summer Weekend No-Build forecast
Previous 2035 No-Build Alternative Forecast	44,100	9,722 (Planned and expected development north of critical link)	4.5	Adjustment of planned and expected units has minimal effect on trip rate.
Previous Assumed Maximum Daily Flow = 35,000 VPD	35,000	9,722	3.6	To reach planned and expected levels, trip rate falls to 3.6 trips/du, implying a 20 percent reduction in willingness to travel.
New 2040 No-Build Forecast	42,800	9,722 (Planned and expected development north of critical point)	4.4	Very similar to 2012 trip rate analysis.
New Assumed Maximum Daily Flow = 31,900	31,900	9,722	3.3	To reach planned and expected levels, trip rate falls to 3.3 trips/du, implying a 25 percent reduction in willingness to travel.

Notes: Both the 2035 and 2040 No-Build Alternative forecasts did not assume a maximum daily capacity restraint and exceed the computed maximum capacity (of 35,000 vpd and 31,900 vpd respectively) in this 2017 analysis. The existing conditions trip ratio (4.4 trips per unit) was computed based on the 2015 analysis of existing conditions applied in the updated 2040 forecast analysis.

The trip rates in Table 8 present a snapshot of volumes passing a specific link and would vary depending upon the roadway link in the network. Unlike a traditional trip rate that would estimate the number of

trips entering and leaving a specific trip generator throughout the day, this trip rate only estimates the number of trips passing a specific point. The total number of trips generated by the development will include local trips that remain north of the critical point and never pass through the 13th Avenue intersection. In addition, there may be zones with a high percentage of trips passing through the link and other zones located further north with a lower percentage of trips. The updated forecasting methods used in the 2040 forecasts take into account these zonal patterns. For this reason, care must be taken in not applying more extensive conclusions based on this trip rate analysis.

CONSTRAINED DEVELOPMENT ANALYSIS

Using the assumptions and analysis outlined in the previous sections, analysis was conducted to identify the potential reduction in development because of traffic capacity constraints if either the No-Build Alternative or ER2 scenarios were to occur. As identified in Table 7, development restrictions are not anticipated if the proposed Mid-Currituck Bridge is constructed (Preferred Alternative).

In identifying the potential development constraints, it is acknowledged that there may be differences between analysis assumptions and methods as compared with actual future development. For this reason, two variables were subjected to sensitivity analyses as follows:

- The potential effect of additional development on the NC 12 trip rate, and
- The potential effect of additional development modifying the peak period spreading of traffic demand.

POTENTIAL REDUCTIONS IN DEVELOPMENT DUE TO TRAFFIC CONGESTION

To evaluate the potential for roadway capacity to constrain development, the amount of land use development was reduced by a percentage corresponding to the percentage of forecasted traffic over the maximum capacity. Based on this trip rate, the number of developed units north of the critical point south of Duck was determined. To examine the impact on all Outer Banks zones, the 3,400 dwelling units in Zones J and K were included in this sensitivity analysis.

A computation of the number of dwelling units and the resulting percent of planned and expected development levels is illustrated in Table 9 for the No-Build Alternative, ER2, and the Preferred Alternative. A review of Table 9 indicates:

- The No-Build Alternative would constrain development in all zones to 81 percent (compared to 83 percent in the 2012 analysis) of planned and expected development.
- ER2 would constrain development in all zones to 88 percent (same as in the 2012 analysis) of planned and expected development.
- With the Mid-Currituck Bridge, there are no constraints on planned and expected development resulting from traffic flow congestion.

Table 9. Computation of Constrained Development based on Traffic Demand at Critical Point

Full Planned and Expected Development, Zones north of Critical Point	**No-Build**	**ER2**	**Preferred Alternative**
Full Planned and Expected Development- Dwelling units north of Critical Point	9,722	9,722	9,722
2040 Weekend Daily Traffic Forecast at Critical Point	42,800	42,800	25,000
Critical Point (NC 12) Maximum Daily Traffic Capacity	31,900	36,000	31,900
Percent of Demand Served due to Capacity Constraint	75%	84%	100%
Constrained Development, Zones north of Critical Point	7,246	8,177	9,722
Planned and Expected Development (Zones L through P) Scenario	**No-Build**	**ER2**	**Preferred Alternative**
Total Dwelling Units	9,722	9,722	9,722
Undeveloped Dwelling Units	2,476	1,545	0
Developed Dwelling Units	7,246	8,177	9,722
Percent Developed of Total	***75%***	***84%***	***100%***
Planned and Expected Development (All zones, J through P) Scenario	**No-Build**	**ER2**	**Preferred Alternative**
Total Dwelling Units	13,122	13,122	13,122
Undeveloped Dwelling Units	2,476	1,545	0
Developed Dwelling Units	10,646	11,577	13,122
Percent Developed of Total	***81%***	***88%***	***100%***
Maximum Build-out (All zones, J through P) Scenario	**No-Build**	**ER2**	**Preferred Alternative**
Total Dwelling Units	15,418	15,418	15,418
Undeveloped Dwelling Units	4,772	3,841	0
Developed Dwelling Units	10,646	11,577	15,418
Percent Developed of Total	***69%***	***75%***	***100%***

Applying constrained development levels to the maximum build-out of 15,418 units (instead of planned and expected development of 13,122 units) as shown in Table 9 for all zones from Southern Shores to the Virginia line shows a potential constraint on development at 69 percent of maximum build-out with the No-Build Alternative and 75 percent with ER2. Note, however, that development along the non-road accessible section of NC 12 is likely to be constrained by other limitations including the traffic capacity for beach driving. Full development (beyond the assumed planned and expected development) would likely require additional infrastructure improvements that are not part of the current local or state plans.

In order to analyze traffic volumes with constrained development, it was necessary to examine the location of the constrained development within the project area north of the critical point. This review considered two scenarios as detailed in the following section.

Two sensitivity analyses were conducted to examine the potential impact of increased development beyond the anticipated identified development constraint for the No-Build Alternative and ER2 scenarios. The two analyses included: (1) the potential effect of additional development resulting in reductions in the NC 12 trip rate, and (2) the potential effect of additional development increasing the duration of the peak period.

LOCATION OF POTENTIAL CONSTRAINED DEVELOPMENT

In order to evaluate the impact that constrained development could have on traffic flows, it was necessary to identify the likely locations that development constraints would prevent a zone from reaching maximum buildout. As identified in the previous section, the overall development constraint was for all zones north of the critical point at the intersection of NC 12 with 13th Avenue/ Sea Oats Drive. This included Zones L, M, N1, N2, O1, O2 and P, as shown in **Error! Reference source not found.**1. Within the total area of these zones, congestion would potentially constrain development to 75 percent (of full planned and expected development) in the 2040 No-Build Alternative and to 84 percent in the 2040 ER2 scenario as shown in Table 9.

An initial assignment of traffic to zones assumed that development in all zones would be constrained by the same overall percentage (75 percent and 84 percent for the No-Build Alternative and ER2 scenarios, respectively). Upon review of this scenario, a second variation was considered that assumed in areas that are almost fully developed (Zones L and M in Duck as well as Zone O and P in northern Currituck County including Corolla) would fully develop because of higher demand in these areas. In Zones N1 and N2 in southern Currituck County, however, there is relatively low growth compared with the developed areas of Southern Shores, Duck and Corolla. In this scenario, all zones except Zones N1 and N2 were allowed to reach planned and expected development and the constrained development restrictions were assumed to concentrate in southern Currituck County.

Table 10 and

Table 11 show the resulting development patterns for the No-Build Alternative and ER2 scenarios, respectively.

Table 10. No-Build Alternative 2040 Constrained Development Assigned to Zones

Land Use Zones	Description	Existing (2014)		Un-Constrained	Constrained No-Build Assume Evenly Split		Constrained No-Build Assume in Zone N only	
		Developed Units	Undeveloped Units	Developed Units	New Units	Developed Units	New Units	Developed Units
P	Non-Road Accessible	731	123	854	28	759	123	854
O	Northern Currituck	1,577	173	1,750	39	1,616	173	1,750
N	Southern Currituck	2,337	2,782	5,119	625	2,962	306	2,643
L,M	Duck	1,883	116	1,999	26	1,909	116	1,999
J,K	Southern Shores	3,037	363	3,400	363	3,400	363	3,400
Zones LMNOP		6,528	3,194	9,722 *(100%)*	718	7,246 *(75%)*	718	7,246 *(75%)*

All Zones		9,565	3,557	13,122 *(100%)*	1,081	10,646 *(81%)*	1,081	10,646 *(81%)*

Table 11. ER2 2040 Constrained Development Assigned to Zones

Land Use Zones	Description	Existing (2014)		Un-Constrained	Constrained ER2 Assume Evenly Split		Constrained ER2 Assume in Zone N only	
		Developed Units	Undeveloped Units	Developed Units	New Units	Developed Units	New Units	Developed Units
P	Non-Road Accessible	731	123	854	64	795	123	854
O	Northern Currituck	1,577	173	1,750	89	1,666	173	1,750
N	Southern Currituck	2,337	2,782	5,119	1,436	3,773	1,237	3,574
L,M	Duck	1,883	116	1,999	60	1,943	116	1,999
J,K	Southern Shores	3,037	363	3,400	363	3,400	363	3,400
Zones LMNOP		6,528	3,194	9,722 *(100%)*	1,649	8,177 *(84%)*	1,649	8,177 *(84%)*
All Zones		9,565	3,557	13,122 *(100%)*	2,012	11,577 *(88%)*	2,012	11,577 *(88%)*

A review of Table 10 and

Table 11 indicate the following observations:

- Assuming that development constraints would tend to affect southern Currituck County more than other areas of the NC 12 project area, about 320 units for No-Build Alternative and about 200 units for ER2 are shifted from southern Currituck County to the other zones. The total amount of resulting development remains unchanged.
- For the 2012 analysis, it was assumed that the scenarios with development constraints focused in zone N (N1 and N2) in southern Currituck County was applicable.
- Of the 2,782 undeveloped units in zones N1 and N2, approximately 306 to 1,237 units are developed for constrained No-Build Alternative and constrained ER2 scenarios respectively. Depending upon the scenario, 1,550 to 2,450 lots may remain undeveloped because of potential traffic constraints.
- As shown in Table 2, over 1,000 of the 2,782 undeveloped units in zones N1 and N2 are anticipated to be hotel rooms.

- The analysis assumes that growth in Zone P will have planned and expected development of 854 lots compared to 3,150 lots that have been subdivided. This assumption is discussed under the section Land Use Assumptions on page 2.

SENSITIVITY ANALYSES

SENSITIVITY ANALYSIS OF TRIP RATES

The first variable in the sensitivity analysis focused on examining the potential effect of additional development resulting in changes to the NC 12 trip rate. A drop in the number of summer weekend trips through the critical point that are not associated with rental home and hotel arrivals and departures could provide the opportunity for more rental home and hotel arrivals and departures to pass through the critical point. This could decrease the constraint on development and increase the number of visitors on the road network on both the summer weekday and weekend. Opportunities for reducing non-arrival and departure trips include increases in:

- Employee car and van-pooling
- The number of permanent and second-home residents who choose to not make trips through the critical point on summer weekends
- The number of visitors who choose not to pass through the critical point on the summer weekend except for arrival and departure.

The sensitivity analysis of trip rates found (Table 12):

- With the revised No-Build Alternative, the maximum number of trips that can pass through the critical point on a summer weekend is approximately 31,880 vehicles per day when assuming a 10-hour peak period and a total of 16 congested hours. With a trip rate of approximately 4.4 trips per dwelling unit, the maximum number of units served north of the critical point would be 7,245 dwelling units (31,880 divided by 7,245 is approximately 4.4) of the 9,722 dwelling units associated with planned and expected development. If the trip rate were to drop to approximately 3.3 trips per dwelling unit, then all 9,722 planned and expected units north of the critical point could be served.
- With the revised ER2, the maximum number of trips that can pass through the critical point on a summer weekend is approximately 36,000 vehicles per day when assuming a 10-hour peak period and a total of 16 congested hours. With a trip rate of approximately 4.4 trips per dwelling unit, the maximum number of dwelling units served north of the critical point would be 8,177 (36,000 divided by 8,177 is approximately 4.4) of the 9,722 dwelling units associated with planned and expected development. If the trip rate were to drop to 3.7 per dwelling unit, then all 9,722 planned and expected units north of the critical point could be served.

Table 12. Sensitivity Analysis of Trip Rates

	No-Build	ER2
2040 Weekend Daily Traffic Forecast at Critical Point	42,800	42,800
Critical Point (NC 12) Maximum Daily Traffic Capacity	31,900	36,000
Full Planned and Expected Development (Zones L through P)	No-Build	ER2
Total Units north of Critical Point	9,722	9,722

Unconstrained Trip Rate	4.40	4.40
Constrained Trip Rate	3.28	3.70
Change in Trip Rate	-25%	-16%
Maximum Build-out (Zones L through P)	No-Build	ER2
Total Units north of Critical Point	12,018	12,018
Constrained Trip Rate	2.65	3.00
Change in Trip Rate	-40%	-32%

The trip rate south of the critical point is assumed to be the same for constrained and unconstrained scenarios.

The trip rate per dwelling unit for development north of the critical point has declined since 1995. Available data shows that the trip rate through the critical point was approximately 5.4 trips per dwelling unit in 1995, 4.7 in 2007, 4.5 in 2012, and 4.4 in 2015. The decline likely results from a combination of the growth in services and commercial development in Currituck County and the growing congestion on NC 12. The growing congestion may reduce the incentive to travel through the critical point other than trip arrival and departure, but the growth in services and commercial development adds trips north of the critical point on weekends including an increase in the number of employees that must pass through the critical point to reach jobs. The greatest decline occurred between 1995 and 2007 (0.9 trips per dwelling unit over 8 years). Since that time the rate of decline was much less (0.3 trips per dwelling unit over 8 years from 2007 to 2015. This could indicate that any further declines would be small.

Thus, while further small reductions in the trip rate are possible, the chance that the trip rate would decrease from 4.4 to 3.3 (25 percent drop with the revised No-Build Alternative) or 3.7 (16 percent with ER2) is considered very small.

SENSITIVITY ANALYSIS OF PEAK PERIOD DURATION

The maximum capacity used in determining the constrained development restrictions was based on an assumption that the growth in travel demand through the critical point on the summer weekend would stop if traffic congestion reached a point where LOS F would occur more than 10 hours per day, with congestion occurring at LOS E for an additional three hours before and after the 10 hours for a total of 16 congested hours. A sensitivity analysis of peak period duration was conducted to examine what levels of delay would be anticipated if the planned and expected development (of 9,722 units north of the critical point) were assumed to occur with the revised No-Build and ER2 scenarios in 2040. The trips per dwelling unit of approximately 4.4 was not changed.

It was found that instead of a 10-hour peak period with a total 16 hours of congestion the following would occur:

- Revised No-Build Alternative: 22-hour peak period with congestion 24-hours a day.
- Revised ER2: 18-hour peak period with congestion 24-hours a day.

The 16 hours used in the constrained development assumed that congested traffic levels begin at 6 AM and end at 10 PM. Although not congested in the first and last hours, peak period demand is assumed to spread to 5 AM and 11 PM. The 10 hours peak period assumption used in the 1995 and the current

analysis (as illustrated in Table 5) was an attempt to develop an assumption of a reasonable limit on summer weekend congestion duration.

It seems unlikely that the peak period would spread further given that the 16-hour congested period likely contains the working hours of most workers north of the critical point and the number of visitors willing to arrive at their vacation home late in the evening or leave their vacation homes in the early morning is likely very small. The chance that an 18 or 22-hour peak period associated with build-out of all planned and expected development would occur is negligible.

TRAFFIC ESTIMATE

The constrained development land use from Table 10 and

Table 11 was used to develop an estimate of constrained 2040 traffic volumes for both the 2040 No-Build Alternative and 2040 ER2 scenarios. The resulting daily traffic volumes for constrained conditions is shown in Table 13. The volumes are compared with the official unconstrained 2040 No-Build and ER2 traffic forecasts.

As would be expected, the constrained No-Build Alternative and constrained ER2 forecasts are lower than the official unconstrained No-Build Alternative/ER2 forecasts. This reflects the constrained development along NC 12 that results in 25 percent and 16 percent less developed units for the No-Build Alternative and ER2 scenarios, respectively.

The primary impact of the constrained development is at Link 10. This is the critical capacity roadway section located just north of the NC 12 at 13th Avenue/Sea Oats Trail Drive intersection. The exact daily traffic volumes on this link, however, must be viewed in context of the specific location of the bottleneck. At the southernmost section of the link at the 13th Avenue/ Sea Oats Trail intersection the daily traffic volume is higher than the weighted average daily traffic that would occur on the entire roadway section as it continues north into Duck. The difference between daily traffic at the intersection (42,800 vpd) and the reported forecast for this link (40,300 vpd) is 2,500 vpd (a difference of 6 percent).

As shown in Table 13, the reported summer weekend daily traffic (weighted average) at this link is 29,900 vpd for the constrained revised No-Build Alternative and 34,600 vpd for the constrained revised ER2. This is 2,000 vpd (about 6 percent) lower than the revised No-Build Alternative capacity of 31,900 vpd.

NETWORK CONGESTION MEASURES

Reductions in development because of NC 12 capacity constraints will result in changes in traffic patterns and traffic volumes. In order to quantify these changes, an analysis of network congestion was conducted to compare issues with constrained versus non-constrained development scenarios.

The initial step in this analysis was to develop an estimate of traffic volumes with constrained land use to compare with the official traffic forecasts for the No-Build Alternative and ER2 alternatives. Note that constrained development is not anticipated with the Preferred Alternative (i.e. build the proposed Mid-Currituck Bridge). Therefore, no additional analysis was done for the Preferred Alternative.

Using the constrained traffic estimates, as shown in Table 13, network congestion measures were evaluated. The same network congestion measures were developed for the Final EIS traffic forecasts and documented in the *Mid-Currituck Bridge Study 2040 Traffic Alternatives Report* (WSP, August 2017). The Final EIS network congestion measures were described in the *Mid-Currituck Bridge Study 2035 Traffic Alternatives Report* (Parsons Brinckerhoff, 2009). New network congestion measures were developed for:

- 2040 Revised No-Build Alternative with Constrained Development
- 2040 Revised ER2 Alternative with Constrained Development

These network congestion measures include:

- Illustrative summary level of service (LOS) by road link in the project area for:
  - Summer weekday
  - Summer weekend

Table 13 2040 Traffic Estimate – Unconstrained and Constrained No-Build and ER2

TRAFFIC ESTIMATE (LINK BASED)				UNCONSTRAINED 2040 NO-BUILD / ER2					CONSTRAINED 2040 NO-BUILD					CONSTRAINED 2040 ER2				
Link #	Route	Location	Between	AADT	Non-Summer Weekday	Non-Summer Weekend	Summer Weekday	Summer Weekend	AADT	Non-Summer Weekday	Non-Summer Weekend	Summer Weekday	Summer Weekend	AADT	Non-Summer Weekday	Non-Summer Weekend	Summer Weekday	Summer Weekend
1	US 158	south of Barco	Barco and Mid-Currituck Bridge	26,100	22,300	25,200	29,300	64,200	23,800	20,300	23,000	26,700	59,000	25,000	21,400	24,200	28,100	61,800
2	US 158	near Bertha	Mid-Currituck Bridge and Grandy	24,700	21,100	23,900	27,800	63,200	22,400	19,200	21,700	25,200	58,000	23,600	20,100	22,800	26,500	60,900
3	US 158	near Jarvisburg	Grandy and Powells Point	27,300	23,300	26,400	30,700	66,200	24,500	20,900	23,700	27,500	60,800	25,900	22,100	25,000	29,100	63,700
4	US 158	near Mamie	Powells Point and Point Harbor	30,600	26,100	29,600	34,400	69,200	27,500	23,500	26,600	30,900	63,500	29,100	24,900	28,100	32,700	66,600
5	US 158		Wright Memorial Bridge	30,600	26,100	29,600	34,400	69,200	27,600	23,600	26,700	31,000	63,600	29,200	24,900	28,200	32,800	66,600
6	US 158		Barlow Lane and Cypress Knee Trail	34,900	29,800	33,700	39,200	72,000	31,800	27,100	30,700	35,700	66,600	33,500	28,600	32,300	37,600	69,500
7	US 158		Cypress Knee Trail and NC 12	41,400	35,300	40,000	46,500	79,400	37,800	32,300	36,600	42,500	73,800	39,700	33,900	38,400	44,600	76,700
8	US 158		south of NC 12 and Eckner St	43,100	36,800	41,600	48,400	69,400	40,600	34,700	39,200	45,600	66,000	41,800	35,700	40,400	47,000	67,200
9A	NC 12		US 158 and Dogwood Trail	30,000	25,600	29,000	33,700	42,200	23,500	20,100	22,700	26,400	33,400	26,800	22,900	25,900	30,100	37,500
9B	NC 12		Dogwood Trail and Sea Oats Trail	28,700	24,500	27,700	32,200	41,300	21,800	18,600	21,100	24,500	31,900	25,100	21,400	24,300	28,200	36,200
10	NC 12	Duck business area	Sea Oats Trail and Christopher Dr	27,000	23,000	26,100	30,300	40,300	19,600	16,700	18,900	22,000	29,900	23,100	19,700	22,300	25,900	34,600
11	NC 12	Sanderling Inn area	Christopher Dr and Audubon Dr	23,300	19,900	22,500	26,200	36,400	16,100	13,800	15,600	18,100	26,100	19,400	16,600	18,700	21,800	30,700
14	NC 12	north of County line	Audubon Dr and Currituck Clubhouse Rd	22,800	19,500	22,000	25,600	31,100	15,200	13,000	14,700	17,100	21,500	18,600	15,900	18,000	20,900	25,800
12B	NC 12	Corolla south	Currituck Clubhouse Rd and Albacore St	21,800	18,600	21,100	24,500	25,700	15,000	12,800	14,400	16,800	18,800	17,600	15,000	17,000	19,800	21,500
12A	NC 12	Corolla north	Albacore St and Mid-Currituck Bridge	13,500	11,600	13,100	15,200	16,000	13,300	11,300	12,800	14,900	15,400	13,500	11,600	13,100	15,200	15,800
13	NC 12	northern end	just north of Shad St	10,900	9,300	10,500	12,200	13,400	10,600	9,000	10,200	11,900	12,900	10,900	9,300	10,500	12,200	13,200

- Miles of congested roadway at LOS E, F, and Poor F on the summer weekday, summer weekend, and weighted average of summer weekday and summer weekend.
- Duration of congestion on each road link with level-of-service LOS E, F, and Poor F.
- Congested annual millions of vehicle-miles traveled (VMT), including total congested VMT (LOS E and higher), VMT with LOS F, and VMT at Poor F.

These are the same network congestion measures developed for use in the Final EIS to measure project need and the project travel benefits. Travel time did not need to be revised for constrained traffic conditions. In general, when the system reaches extreme congested conditions (which would be required to constrain planned and expected development), the addition of extra vehicles effectively results in peak hour spreading and more hours of congestion per day. In the peak periods, however, any changes in travel time would be minimal.

LOS AND V/C RATIO

A capacity analysis was also conducted using HCS derived capacities at the link level for each of the 16 links in the model. This is a planning level capacity analysis using a lookup table derived from the link level capacities for each LOS threshold. The methodology and the capacities used in the analysis is included in the Mid-*Currituck Bridge Study 2040 Traffic Alternatives Report* (WSP, 2017).

The customary LOS classifications of A (free-flowing traffic) to F (highly congested traffic with travel demand equaling or exceeding the capacity of each road link in the thoroughfare system) were used. At LOS E or higher traffic is considered congested. Travel demand is how many vehicles want to travel on a road in an hour. Capacity is the number of vehicles a road can actually carry in an hour.

A classification of Poor F also was used, defined as travel demand of 30 percent higher than the capacity of the road. If, for example, a road has the capacity to carry 10,000 vehicles in an hour and demand is 13,000 vehicles in an hour, then demand is 30 percent over capacity. The volume/capacity ratio is the ratio of hourly travel demand to one-hour road capacity. When peak hour travel demand exceeds the capacity of a road, then the travel demand spreads to other hours where unused capacity still exists, lengthening the peak period.

The link level of service analysis was initially conducted and summarized for the *Mid-Currituck Bridge Study 2040 Traffic Alternatives Report* (WSP, 2017). This analysis included the 2040 No-Build and 2040 ER2 scenario assuming no constraints on planned and expected development. For this evaluation of constrained traffic, the unconstrained and constrained forecasts are shown for both the Revised No-Build and ER2 alternatives. The analysis is illustrated in Table 14 and Figure 3 through Figure 6. The revised No-Build Alternative is defined as including the existing thoroughfare network plus State Transportation Improvement Program (STIP) 2018 to 2027 project R-3419, access improvements to US 158 from the Wright Memorial Bridge to US 64.

Each figure shows an illustration of the roadway network. Color coding is used to illustrate the roadway LOS with solid lines showing Summer Weekday and dashed line showing Summer Weekend LOS. In

addition, the ratio of demand to capacity is shown for those links exceeding the capacity of the roadway. The amount of peak hour spreading anticipated to occur is also shown at key congestion points.

Table 14 LOS and V/C Ratio for Unconstrained and Constrained No-Build Alternative and ER2

Link #	Route	Between	Alternative	Summer Weekday		Summer Weekend	
				LOS	V/C	LOS	V/C
1	US 158	Barco and Mid-Currituck Bridge	Unconstrained No-Build	B	0.34	D	0.86
			Constrained No-Build	A	0.31	D	0.79
			Unconstrained ER2	B	0.34	D	0.86
			Constrained ER2	B	0.32	D	0.83
2	US 158	Mid-Currituck Bridge and Grandy	Unconstrained No-Build	B	0.32	D	0.85
			Constrained No-Build	A	0.29	D	0.78
			Unconstrained ER2	B	0.32	D	0.85
			Constrained ER2	A	0.30	D	0.81
3	US 158	Grandy and Powells Point	Unconstrained No-Build	B	0.35	D	0.89
			Constrained No-Build	B	0.31	D	0.81
			Unconstrained ER2	B	0.35	D	0.89
			Constrained ER2	B	0.33	D	0.85
4	US 158	Powells Point and Point Harbor	Unconstrained No-Build	B	0.39	E	0.93
			Constrained No-Build	B	0.35	D	0.85
			Unconstrained ER2	B	0.39	E	0.93
			Constrained ER2	B	0.37	D	0.89
5	US 158	Wright Memorial Bridge	Unconstrained No-Build	B	0.39	E	0.93
			Constrained No-Build	B	0.35	D	0.85
			Unconstrained ER2	B	0.39	E	0.93
			Constrained ER2	B	0.38	D	0.89
6	US 158	Barlow Lane and Cypress Knee Trail	Unconstrained No-Build	C	0.58	F	1.15
			Constrained No-Build	C	0.52	F	1.06
			Unconstrained ER2	B	0.37	D	0.75
			Constrained ER2	B	0.36	D	0.72
7	US 158	Cypress Knee Trail and NC 12	Unconstrained No-Build	D	0.68	F	1.26
			Constrained No-Build	C	0.63	F	1.18
			Unconstrained ER2	B	0.44	D	0.82
			Constrained ER2	B	0.43	D	0.79
8	US 158	NC 12 and Eckner Street	Unconstrained No-Build	D	0.71	F	1.11
			Constrained No-Build	D	0.67	F	1.05
			Unconstrained ER2	D	0.71	F	1.11
			Constrained ER2	D	0.69	F	1.07
9A	NC 12	US 158 and Dogwood Trail	Unconstrained No-Build	F	1.12	F	1.48
			Constrained No-Build	E	0.88	F	1.17
			Unconstrained ER2	F	1.12	F	1.48
			Constrained ER2	F	1.00	F	1.32
9B	NC 12	Dogwood Trail and Sea Oats Trail / 13th Avenue	Unconstrained No-Build	F	1.21	F	1.64
			Constrained No-Build	E	0.92	F	1.27
			Unconstrained ER2	F	1.07	F	1.45
			Constrained ER2	E	0.94	F	1.27
10	NC 12	Sea Oats Trail / 13th Avenue and Christopher Drive	Unconstrained No-Build	F	1.01	F	1.42
			Constrained No-Build	E	0.73	F	1.05
			Unconstrained ER2	F	1.01	F	1.42
			Constrained ER2	E	0.86	F	1.22

Link #	Route	Between	Alternative	Summer Weekday		Summer Weekend	
				LOS	V/C	LOS	V/C
11	NC 12	Christopher Drive and Audubon Drive	Unconstrained No-Build	E	0.74	F	1.09
			Constrained No-Build	D	0.51	E	0.78
			Unconstrained ER2	E	0.74	F	1.09
			Constrained ER2	D	0.62	E	0.92
14	NC 12	Audubon Drive and Currituck Clubhouse Road	Unconstrained No-Build	E	0.81	E	0.88
			Constrained No-Build	D	0.54	D	0.61
			Unconstrained ER2	E	0.81	E	0.88
			Constrained ER2	E	0.66	E	0.73
12B	NC 12	Currituck Clubhouse Road and Albacore Street	Unconstrained No-Build	E	0.92	E	0.86
			Constrained No-Build	E	0.63	E	0.63
			Unconstrained ER2	E	0.92	E	0.86
			Constrained ER2	E	0.74	E	0.72
12A	NC 12	Albacore Street and Mid-Currituck Bridge	Unconstrained No-Build	D	0.48	D	0.45
			Constrained No-Build	D	0.47	D	0.44
			Unconstrained ER2	D	0.48	D	0.45
			Constrained ER2	D	0.48	D	0.45
13	NC 12	Mid-Currituck Bridge and north of Shad Street	Unconstrained No-Build	C	0.39	C	0.38
			Constrained No-Build	C	0.38	C	0.37
			Unconstrained ER2	C	0.39	C	0.38
			Constrained ER2	C	0.39	C	0.37

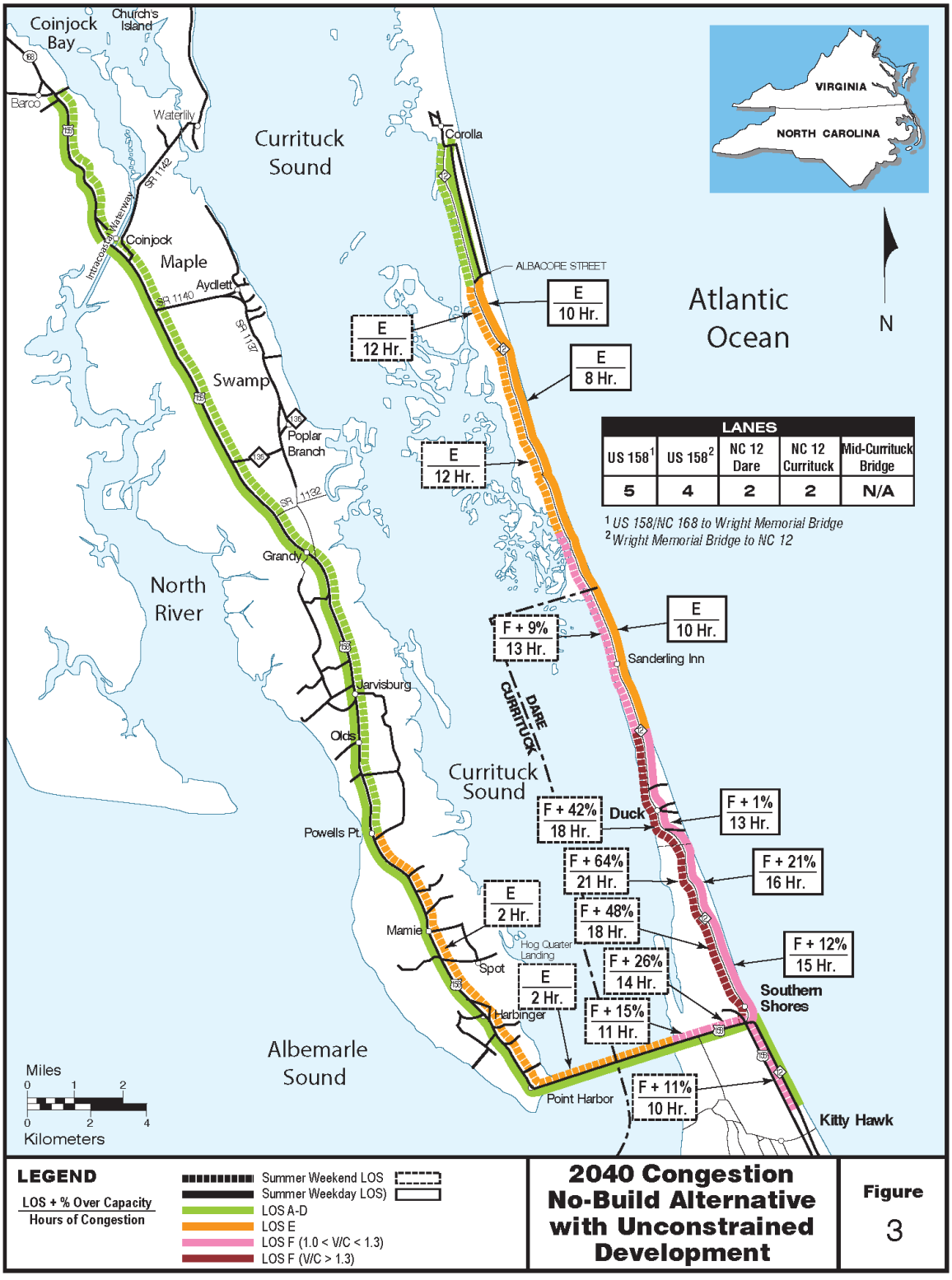

Figure 3: 2040 No-Build – Unconstrained Analysis

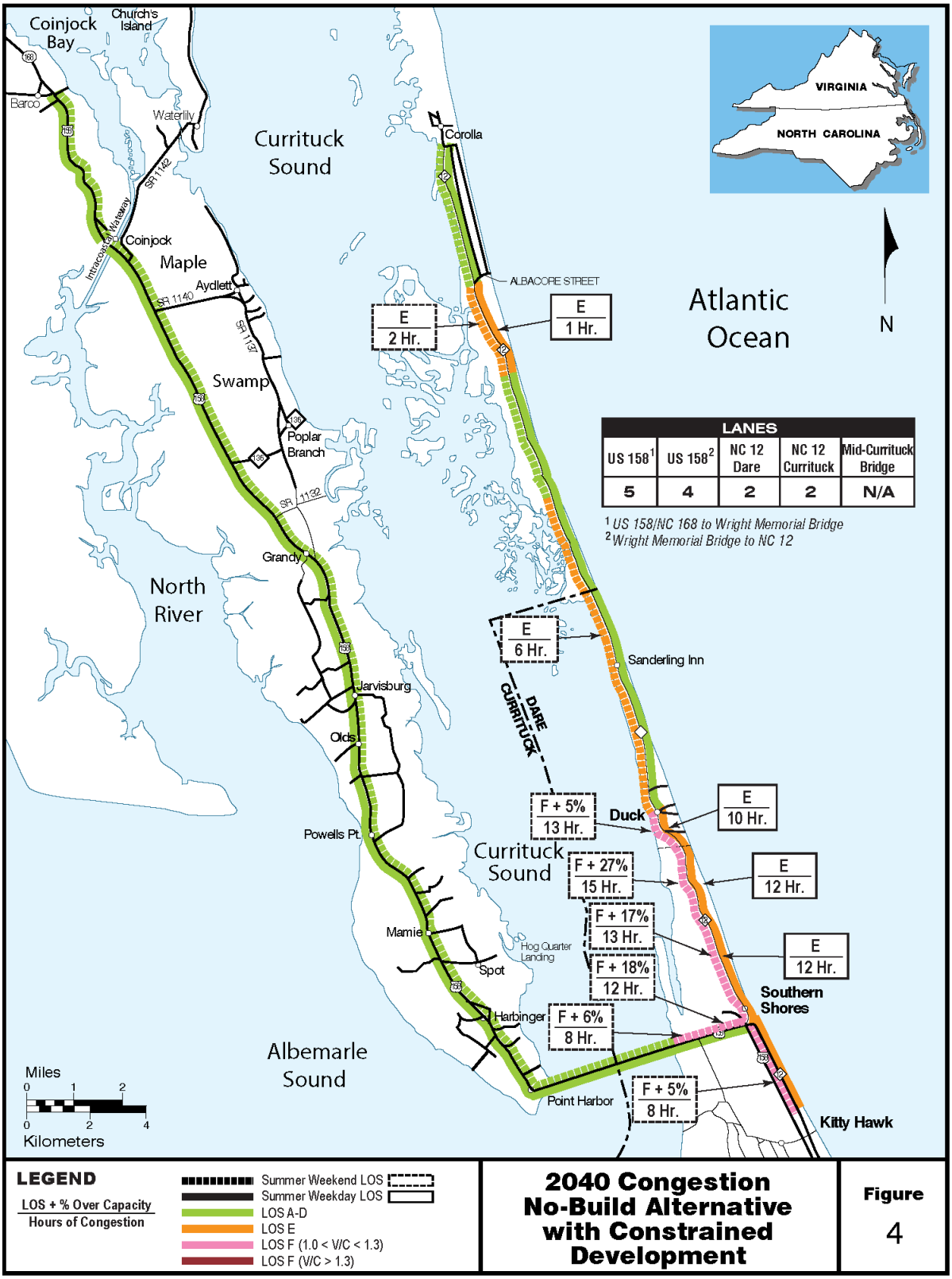

Figure 4: 2040 No-Build - Constrained Analysis

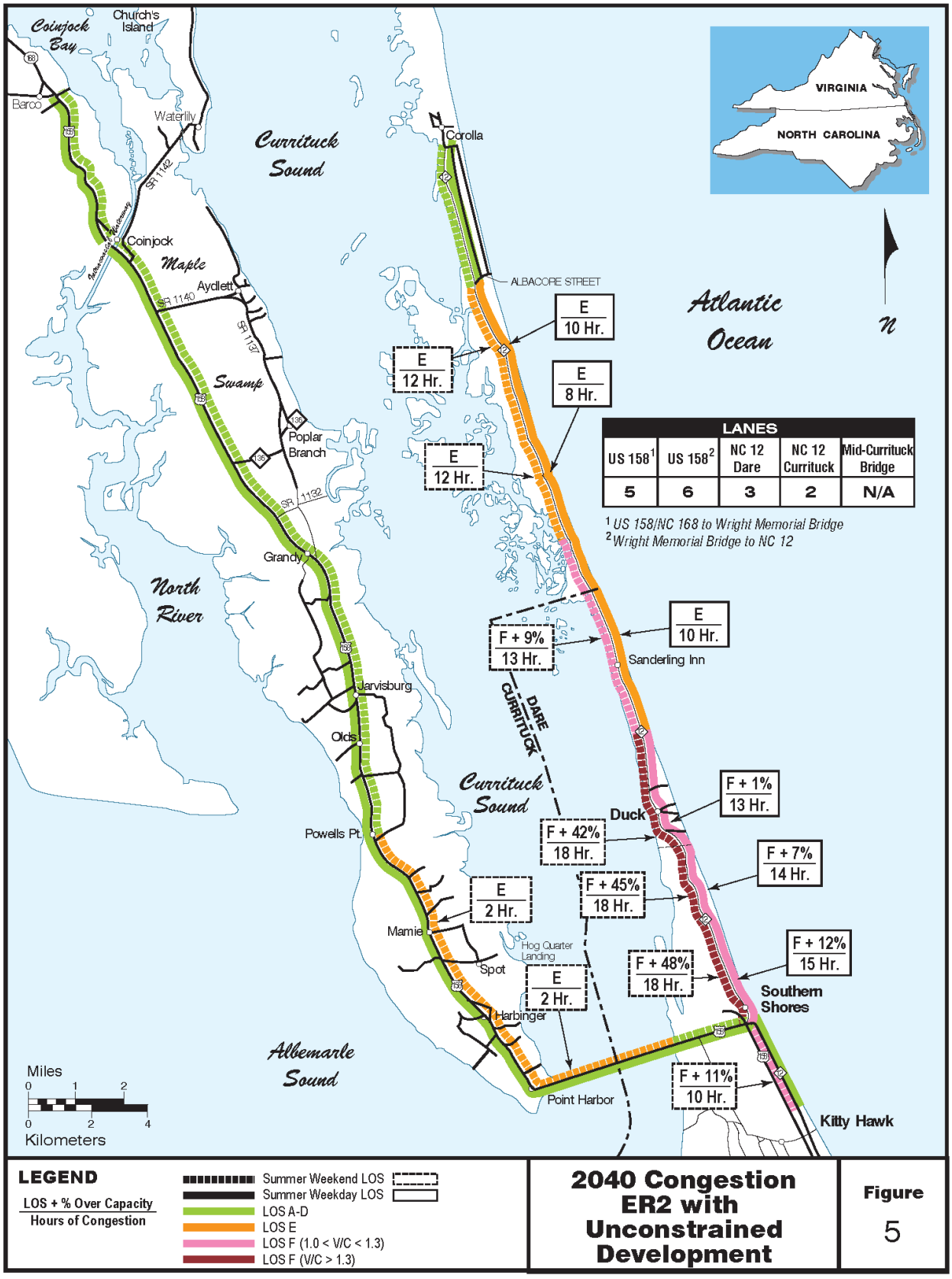

Figure 5: 2040 ER2 - Unconstrained Analysis

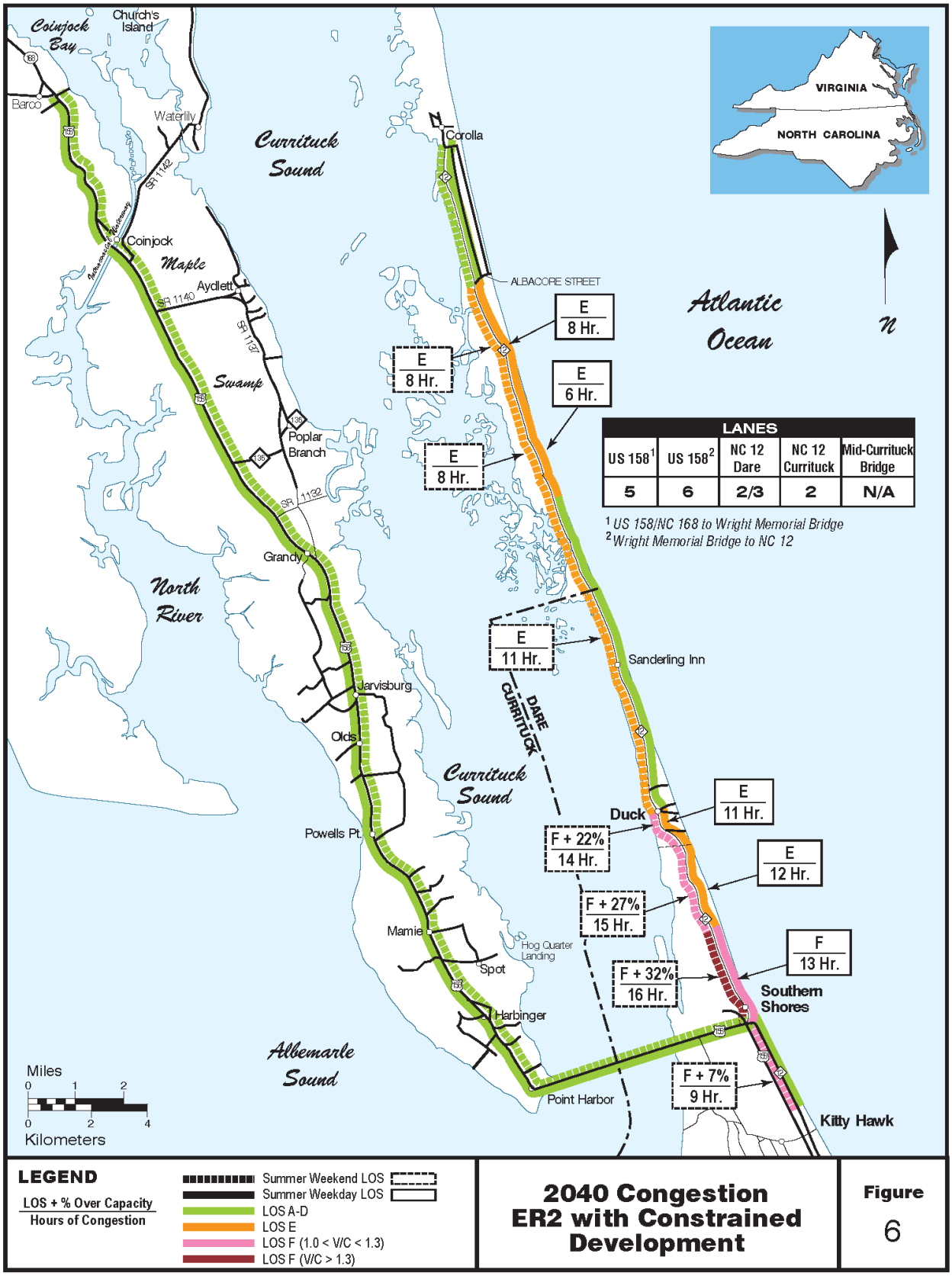

Figure 6: 2040 ER2 – Constrained Analysis

DURATION OF CONGESTION

Each of the 16 links in the roadway network for which a traffic estimate was developed was analyzed to determine the number of hours with congested traffic flow. In general, the non-summer periods had no congestion, the summer weekday had specific links with congestion, and the summer weekend had high levels of congestion extending for more than 10 hours per day on some links. This review focused on a comparison of the unconstrained versus constrained development for the revised No-Build Alternative and revised ER2 scenarios. Table 15 provides a summary of this analysis.

Table 15. Duration of Congestion

Link #	Route	Between	Alternative	Summer Weekday	Summer Weekend
1	US 158	Barco and Mid-Currituck Bridge	Unconstrained No-Build	0	0
			Constrained No-Build	0	0
			Unconstrained ER2	0	0
			Constrained ER2	0	0
2	US 158	Mid-Currituck Bridge and Grandy	Unconstrained No-Build	0	0
			Constrained No-Build	0	0
			Unconstrained ER2	0	0
			Constrained ER2	0	0
3	US 158	Grandy and Powells Point	Unconstrained No-Build	0	0
			Constrained No-Build	0	0
			Unconstrained ER2	0	0
			Constrained ER2	0	0
4	US 158	Powells Point and Point Harbor	Unconstrained No-Build	0	2
			Constrained No-Build	0	0
			Unconstrained ER2	0	2
			Constrained ER2	0	0
5	US 158	Wright Memorial Bridge	Unconstrained No-Build	0	2
			Constrained No-Build	0	0
			Unconstrained ER2	0	2
			Constrained ER2	0	0
6	US 158	Barlow Lane and Cypress Knee Trail	Unconstrained No-Build	0	11
			Constrained No-Build	0	8
			Unconstrained ER2	0	0
			Constrained ER2	0	0
7	US 158	Cypress Knee Trail and NC 12	Unconstrained No-Build	0	14
			Constrained No-Build	0	12
			Unconstrained ER2	0	0
			Constrained ER2	0	0

Link #	Route	Between	Alternative	Summer Weekday	Summer Weekend
8	US 158	NC 12 and Eckner Street	Unconstrained No-Build	0	10
			Constrained No-Build	0	8
			Unconstrained ER2	0	10
			Constrained ER2	0	9
9A	NC 12	US 158 and Dogwood Trail	Unconstrained No-Build	15	18
			Constrained No-Build	12	13
			Unconstrained ER2	15	18
			Constrained ER2	13	16
9B	NC 12	Dogwood Trail and Sea Oats Trail / 13th Avenue	Unconstrained No-Build	16	21
			Constrained No-Build	12	15
			Unconstrained ER2	14	18
			Constrained ER2	12	15
10	NC 12	Sea Oats Trail / 13th Avenue and Christopher Drive	Unconstrained No-Build	13	18
			Constrained No-Build	10	13
			Unconstrained ER2	13	18
			Constrained ER2	11	14
11	NC 12	Christopher Drive and Audubon Drive	Unconstrained No-Build	10	13
			Constrained No-Build	0	6
			Unconstrained ER2	10	13
			Constrained ER2	0	11
14	NC 12	Audubon Drive and Currituck Clubhouse Road	Unconstrained No-Build	8	12
			Constrained No-Build	0	0
			Unconstrained ER2	8	12
			Constrained ER2	6	8
12B	NC 12	Currituck Clubhouse Road and Albacore Street	Unconstrained No-Build	10	12
			Constrained No-Build	1	2
			Unconstrained ER2	10	12
			Constrained ER2	8	8
12A	NC 12	Albacore Street and Mid-Currituck Bridge	Unconstrained No-Build	0	0
			Constrained No-Build	0	0
			Unconstrained ER2	0	0
			Constrained ER2	0	0
13	NC 12	Mid-Currituck Bridge and north of Shad Street	Unconstrained No-Build	0	0
			Constrained No-Build	0	0
			Unconstrained ER2	0	0
			Constrained ER2	0	0

MILES OF CONGESTED ROADWAY

Miles of congested roadway was examined in terms of the impacts with and without constrained development for both the No-Build Alternative and ER2 scenarios. To maintain consistency with the previous iterations of analysis, the peak hourly demand was compared to the link capacity to identify a demand V/C ratio. Congested flow was tested using three levels of congestion: LOS E, LOS F (V/C equals or exceeds 1.00), and poor LOS F (V/C equals or exceeds 1.30). Table 16 summarizes the analysis of miles of congested roadway.

Table 16 Miles of Congested Roadway

2040 Conditions	Unconstrained No-Build	Constrained No-Build	Unconstrained ER2	Constrained ER2
Miles of Road Operating at LOS E, F, or Poor LOS F				
Summer Weekday	17.9	7.7	17.9	10.7
Summer Weekend	30.3	17.4	28.9	19.0
Weighted Average	21.4	10.4	21.0	13.1
Miles of Road Operating at LOS F or Poor LOS F				
Summer Weekday	5.8	0.0	5.8	2.3
Summer Weekend	15.5	8.3	14.1	6.9
Weighted Average	8.6	2.4	8.2	3.6
Miles of Road Operating at Poor LOS F				
Summer Weekday	0.0	0.0	0.0	0.0
Summer Weekend	5.8	0.0	5.8	2.3
Weighted Average	1.7	0.0	1.7	0.7

Note: Unconstrained analyses results are from the 2040 Traffic Alternatives Report. Constrained analyses results have been introduced in this memo and had not been reported previously. Network length, excluding Mid-Currituck Bridge, is 51.4 miles.

VEHICLE MILES TRAVELED – TOTAL AND CONGESTED

Vehicle Miles Traveled (VMT) was analyzed for both unconstrained and constrained conditions. In general, lower traffic volumes would result in lower VMT, both overall and congested. Table 17 summarizes the analysis of VMT for the No-Build Alternative and ER2 scenarios under both constrained and unconstrained development. It illustrates the network system's total VMT and the amount of congested VMT.

Table 17 Total and Congested VMT for Multiple Congestion Levels

Vehicle Miles Traveled By Congestion Level	Unconstrained No-Build (2040)	Constrained No-Build (2040)	Unconstrained ER2 (2040)	Constrained ER2 (2040)
Total Network				
All LOS	502.1	426.8	502.1	463.2
LOS E, LOS F and Poor F	96.8 (19.3%)	34.4 (8.1%)	93.7 (18.7%)	50.4 (10.9%)
LOS F and Poor F	23.1 (4.6%)	3.5 (0.8%)	17.3 (3.4%)	4.2 (0.9%)
Poor F	2.4 (0.5%)	0.0 (0%)	2.1 (0.4%)	0.4 (0.1%)
US 158 West of Wright Memorial Bridge				
All LOS	293.6	265.9	293.6	280.2

Vehicle Miles Traveled By Congestion Level	Unconstrained No-Build (2040)	Constrained No-Build (2040)	Unconstrained ER2 (2040)	Constrained ER2 (2040)
LOS E, LOS F and Poor F	3.2 (1.1%)	0 (0%)	3.2 (1.1%)	0 (0%)
LOS F and Poor F	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Poor F	0 (0%)	0 (0%)	0 (0%)	0 (0%)
US 158 East of Wright Memorial Bridge				
All LOS	36.8	34.2	36.8	35.6
LOS E, LOS F and Poor F	3.1 (8.4%)	2.9 (8.5%)	1.3 (3.5%)	1.2 (3.5%)
LOS F and Poor F	2.7 (7.2%)	1.7 (5.0%)	1.0 (2.6%)	0.8 (2.2%)
Poor F	0.0 (0%)	0.0 (0%)	0.0 (0%)	0.0 (0%)
NC 12 (Dare & Currituck)				
All LOS	171.7	126.7	171.7	147.4
LOS E, LOS F and Poor F	90.5 (52.7%)	31.5 (24.9%)	89.2 (51.9%)	49.2 (33.4%)
LOS F and Poor F	20.5 (11.9%)	1.8 (1.4%)	16.3 (9.5%)	3.4 (2.3%)
Poor F	2.4 (1.4%)	0.0 (0%)	2.1 (1.2%)	0.4 (0.2%)

Note: Unconstrained analyses results are from the 2040 Traffic Alternatives Report. Constrained analyses results have been introduced in this memo and had not been reported previously.

TRAVEL TIME

Travel time did not need to be revised for constrained traffic conditions. In general, when the system reaches extreme congested conditions (which would be required to constrain planned and expected development), the addition of extra vehicles effectively results in peak hour spreading and more hours of congestion per day. In the peak periods, however, any changes in travel time would be minimal. In addition, the analysis of constrained conditions travel times would have required a peak period analysis at a much higher level of detail than could be derived for the link level constrained traffic estimates available for this analysis.

SUMMARY OF NETWORK CONGESTION MEASURES

Table 2-3 of the Final EIS presented the travel benefits of the detailed study alternatives. Table 18 compares the traffic flow and travel time benefits presented in Final EIS Table 2-3 for the constrained No-Build Alternative and constrained ER2 scenarios for these key summary measures. The Preferred Alternative is also shown for comparison purposes under the unconstrained development.

Table 18 Travel Benefits for Different Alternatives

Traffic Flow Benefits Summary 2040	Unconstrained Forecast			Constrained Traffic Estimate	
	No-Build	ER2	Preferred Alternative	No-Build	ER2
Congested Annual Vehicle-Miles Traveled (millions)					
Total Congested VMT	96.8	93.7	35.6	34.4	50.4
VMT with Traffic Demand at or Above Road Capacity	23.1	17.3	1.1	3.5	4.2
VMT with Traffic Demand 30% or Above Road Capacity	2.4	2.1	0.0	0.0	0.4
Miles of Road Operating with Traffic Demand at or Above Road Capacity					

Traffic Flow Benefits Summary 2040	Unconstrained Forecast			Constrained Traffic Estimate	
	No-Build	ER2	Preferred Alternative	No-Build	ER2
Summer Weekday (SWD)	5.8	5.8	0.0	0.0	2.3
Summer Weekend (SWE)	15.5	14.1	1.5	8.3	6.9
Weighted Average	8.6	8.2	0.5	2.4	3.6
Miles of Road with Traffic Demand 30 Percent or Above Road Capacity					
Summer Weekday (SWD)	0.0	0.0	0.0	0.0	0.0
Summer Weekend (SWE)	5.8	5.8	0.0	0.5	3.4
Weighted Average	1.7	1.7	0.0	0.1	1.0

Note: Unconstrained analyses results are from the 2040 Traffic Alternatives Report. Constrained analyses results have been introduced in this memo and had not been reported previously.

SUMMARY OF KEY FINDINGS

Two major assumptions have changed since the original 1995 analysis, including:

- The maximum daily capacity of 23,400 used in the original 1995 analysis was based on then current but now old HCS methods for estimating peak hour capacity. The maximum daily capacity was increased to 31,900 vpd for this 2017 analysis.
- The maximum build-out of units along NC 12 anticipated in the original 1995 analysis was adjusted downward. This is primarily because as developers submitted final plats for parts of their planned unit development, they did not include in their final plats the maximum number of units that were allowed by the planned unit development agreement with Currituck County.

Based on the assumptions, methodology and results of this analysis for the revised alternatives, the following observations on development constraints can be made:

- With the No-Build Alternative, development could be constrained at approximately 10,646 units of 13,122 planned and expected units for the area (81 percent).
- With ER2, NC 12 would be widened to three lanes from US 158 to north of Downtown Duck. Development could be constrained at approximately 11,577 units of 13,122 planned and expected units for the area (88 percent), an increase of 7 percent over the No-Build Alternative.
- With the Preferred Alternative, roadway capacity does not constrain development in the area from reaching planned and expected development levels.

Applying constrained development levels to the maximum build-out of 15,518 units from Southern Shores to the Virginia line shows a potential constraint on development at 69 percent of build-out with the constrained No-Build Alternative and 75 percent with constrained ER2 Alternative.